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**WATER QUALITY CONTROL STUDY,
NISHNABOTNA RIVER BASIN, IOWA AND MISSOURI**

**Federal Water Pollution Control Administration
Kansas City, Missouri**

November 1967

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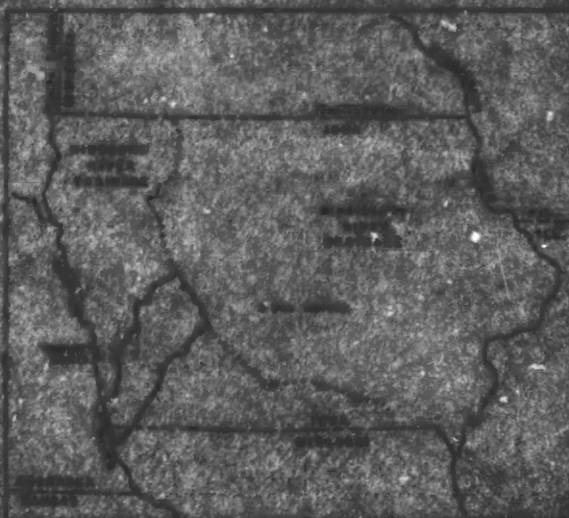
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WATER QUALITY CONTROL STUDY MINNESOTA RIVER BASIN IOWA AND MISSOURI

Study of the Needs and Value of Storage
for Water Quality Control



UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
WASHINGTON, D. C. 20250

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WATER QUALITY CONTROL STUDY

**WISNABOTNA RIVER BASIN
IOWA AND MISSOURI**

A study has been made of the Wishnabotna River Basin which determined that there is a need for storage in reservoirs for water quality control presently and in the future. Audubon, Iowa, on Blue Grass Creek, is presently in need of storage, and by the end of the study period in 2070 will require substantial amounts of storage for water quality control. Harlan, Iowa on the West Wishnabotna River, does not presently require supplementary flow for water quality control; however, beginning in 1980, storage will be required through 2070. These conclusions are based on analysis of existing water quality information and hydrologic, economic and demographic analyses. Future needs are based on projected population and industrial growth.

Prepared for

DEPARTMENT OF THE ARMY

U. S. Army Engineer District

Omaha, Nebraska

U. S. DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration
Kansas City, Missouri

I

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I. INTRODUCTION

Authority

In a letter dated November 5, 1965, the Omaha District of the Corps of Engineers requested the Federal Water Pollution Control Administration to make an investigation of the present and prospective needs for storage for the regulation of streamflow for water quality control in the Nishnabotna River Basin.

This study has been made in accordance with the Federal Water Pollution Control Act, as amended (33 U.S.C. 466 et seq.). The Federal Water Pollution Control Act requires, in Section 3-b, that in the survey or planning of reservoirs for water resources development, the Bureau of Reclamation, the Corps of Engineers, or other Federal agencies consider the inclusion of storage for streamflow regulation for quality control.

Purpose and Scope

➤ The purpose of this study is to determine the present and future needs and value of storage for streamflow regulation for quality control in the Nishnabotna River Basin, a tributary of the Missouri River.

The study covers requirements for streamflow regulation for quality control during the study period of 1970 to 2070. The study area includes parts of the following Iowa counties: Fremont, Page, Mills, Montgomery, Pottawattamie, Cass, Shelby, Audubon, Crawford, and Carroll and a small part of Atchison County in Missouri. (M)

Acknowledgments

The cooperation of the following Federal and State agencies which were contacted for information and assistance is gratefully acknowledged:

U. S. Army Engineer District, Omaha Corps of Engineers

Iowa State Health Department, Division of Public Health
Engineering, Des Moines, Iowa

Missouri Water Pollution Board, Jefferson City, Missouri

II. SUMMARY OF FINDINGS AND CONCLUSIONS

Summary of Findings

1. The Corps of Engineers, Omaha District, is investigating the feasibility of eight reservoirs in the Nishnabotna River Basin. Figure 1 is a map of the basin showing the locations of the proposed reservoirs.
2. The study area is located in the southwestern corner of Iowa and the northwestern corner of Missouri and takes in all or part of the following Iowa counties: Fremont, Page, Mills, Montgomery, Pottawattamie, Cass, Shelby, Audubon, Crawford, and Carroll and a part of Atchison County in Missouri.
3. The area of the Nishnabotna River Basin is 2,995 square miles of which approximately 2,900 square miles are in Iowa.
4. The 1960 population of the study area (including Council Bluffs SMSA) was 186,000 of which 88,000 were rural and 98,000 were urban. Principal municipalities in the basin include Atlantic (6,890), Audubon (2,928), Harlan (4,350), Red Oak (6,421) and Shenandoah (6,567).
5. The major municipalities in the basin have secondary treatment. The population equivalents (P.E.) before and after treatment are as follows: Atlantic, 6,200-1200 P.E.; Audubon, 2,200-200 P.E.; Harlan, 23,400-6,400 P.E.; Red Oak, 6,700-660 P.E.; and Shenandoah, 7,000-700 P.E.
6. The chemical quality of the water in the Nishnabotna Basin is generally within the range set by the U. S. Public Health Service's recommended drinking water standards. However, many of the wells furnish water which is high in iron and total hardness and which requires treatment.

Conclusions

1. The urban population is projected to increase from 98,000 in 1960 to 318,000 by 2070 and the rural population will decrease from 88,000 in 1960 to 72,000 in 2070. These figures are based on projections by the Omaha District Corps of Engineers.

2. By the year 2070, the estimated flows required to effectively assimilate waste loadings during the summer months of June, July, August and September will be 28.6 mgd (million gallons per day) at Harlan on the West Nishnabotna and 4.5 mgd at Audubon on Blue Grass Creek assuming 90 percent reduction of BOD at the two locations. Based on frequency analysis, flows are not available to meet these requirements in 9 out of 10 years.

3. Storage requirements to provide 1,350 acre-feet from Blue Grass Creek Reservoir and 1,450 acre-feet from Harlan Reservoir will be necessary to supply water for low flow augmentation to attain the desired quality 9 out of 10 years in 2070.

4. The value of storage to supply streamflow regulation for quality control is equal to the value of a least cost alternate solution, in this case, a pipeline to transport wastes from Audubon to the East Nishnabotna River. The value of the benefit of storage in the Blue Grass Creek Reservoir to supply the streamflow regulation required at Audubon is \$11,400 per year based on a capital cost of \$316,800 amortized at 3 1/8 percent for 100 years and an annual operation and maintenance cost of \$1,000. The value of storage in Harlan Reservoir is considered to be the value of the most likely alternative which is a holding pond to store excess effluents

which the stream cannot assimilate. The value of the benefit of a holding pond at Harlan to maintain desired water quality is \$7,500 per year based on a capital cost of \$160,000 amortized at a rate of 3 1/8 percent for 100 years and discounted for the year of first need (1980) and an annual operation and maintenance cost of \$5,000.

5. Maintenance of satisfactory water quality in the Neishabotna River Basin will benefit a variety of water uses in the study area. Recreational opportunities including fishing and swimming will be increased. The esthetic values of the stream stemming from clean surface water and a satisfactory healthy water environment will be preserved along with property values near the streams.

III. PROJECT DESCRIPTION

Location

The locations of the eight reservoirs being investigated for feasibility in the Nishabotna River Basin are shown in Figure 1. Except for Steunett (drainage area 870 square miles) on the East Nishabotna River, the reservoirs are located on tributaries near the headwaters of the streams and drain less than 200 square miles. Table III-1 lists the proposed reservoirs and the drainage area, water surface area, and storage.

Table III-1
Wishnabotna River Basin Study
Pertinent Data - Potential Reservoir Sites

<u>Site</u>	<u>Drainage Area in Square Miles</u>	<u>Maximum Permanent Pool in Acres</u>	<u>Conservation Storage Available in Acre-Feet</u>	<u>80% Sediment Res. in Cons. Zone Acre Feet</u>	<u>Balance Available Acre-Feet</u>
David's Creek	57	1,140	7,700	3,300	4,400
Audubon East	77	1,540	19,000	4,400	14,600
Blue Grass Creek	16	320	5,800	900	4,900
Stennett	870	17,400	740,000	30,100	689,900
Harlan	143	2,860	31,000	8,200	22,800
Avoca	200	4,000	123,000	11,500	111,500
Silver Creek	196	3,920	81,000	11,300	69,700
Graybull Creek	100	2,000	60,000	5,800	54,200

Streamflow

Streamflow records are presently being collected at seven stations in the basin. The East Nishnabotna River at Red Oak, and the Nishnabotna River near Hamburg have periods of record of 35 and 38 years, respectively. Table III-2 lists the gaging stations, periods of record and discharges as average, maximum and minimum for all seven stations in the basin.

Table No. III-2

Streamflow Data

<u>No. and Locations of Gaging Stations</u>	<u>Years of Record</u>	<u>Streamflow (cubic feet per second)</u>		
		<u>Average</u>	<u>Maximum</u>	<u>Minimum</u>
8074.1, West Nishnabotna River at Hancock, Iowa	6	270	18,000	12
8080, Mule Creek near Malvern, Iowa	11	4.6	2,070	0
8085, West Nishnabotna River at Randolph, Iowa	17	520	29,600	10
8090, Davids Creek near Hamlin, Iowa	13	10.7	22,700	0
8092.1, East Nishnabotna River near Atlantic, Iowa	5	217	20,500	7
8095, East Nishnabotna River at Red Oak, Iowa	35	358	36,200	6
8100, Nishnabotna River near Hamburg, Iowa	38	973	55,500	4.5

IV. DESCRIPTION OF STUDY AREA

Location and Boundaries

The study area for this report is the Nishnabotna River Basin, which is located in southwestern Iowa and northwestern Missouri. It covers parts of 10 counties in Iowa and a small part of one county in Missouri. The basin is bounded on the east by the drainage areas of the Des Moines River, Nodaway River, and Tarkio River, and on the west by the watersheds of the Boyer River and other smaller tributaries of the Missouri River. The drainage area of the basin is 2,995 square miles of which approximately 2,900 square miles are in Iowa. The main stream is formed by the confluence of the East and West Nishnabotna Rivers, about 12 miles above the mouth. The East Nishnabotna River and its major tributaries include approximately 140 river miles and the West Nishnabotna River and its major tributaries include approximately 225 miles of stream. The river originates at an elevation of about 1,450 feet above mean sea level and joins the Missouri River at an elevation of about 890 feet.

Topography

The Nishnabotna River falls approximately 560 feet from the headwaters to the mouth. The bedrock in the basin is Cretaceous age in the northeastern part with the majority of the basin consisting of Pennsylvanian age strata which varies from Desmoinesian in the upper part to Missourian in the central part and Virgilian in the lower part of the basin. Most of the basin is covered with layers of loess and glacial deposits which may

be as much as 100 feet thick on the western edge and from 30 feet to 8 feet in thickness on the ridges in the northeastern portions. Marshall Silt Loam is the most common upland soil in the basins. Because of these deposits, the bedrock is exposed in only a few places and does not influence the present topography to any extent.

Climate

The normal annual precipitation in the Wisconsin River Basin is about 32 inches and the approximate frost free period varies from 160 days in the lower basin to 150 days in the upper part. Approximately 73 percent of the precipitation falls during the frost free period and is highly favorable to agriculture.

The mean average temperature for this area is approximately 50°F and recorded extremes are 117°F and -35°F.

V. WATER RESOURCES OF THE STUDY AREA

Surface Water

The basin is comprised of two main stem rivers, the East and West Nishnabotna Rivers which join to form the Nishnabotna River about 12 miles above its junction with the Missouri River. The West Nishnabotna River at Randolph has an average annual flow of 520 cfs (cubic feet per second) and the East Nishnabotna River at Red Oak has an average annual flow of 358 cfs. The Nishnabotna River near Hamburg, Iowa, a few miles from the mouth averages 973 cfs. The flow characteristics for the three gaging stations based on the period of record are shown in Table V-1.

Table V-1

Monthly Distribution of Flows*

	<u>W. Nishnabotna R. at Randolph, Ia.</u>	<u>E. Nishnabotna R. at Red Oak, Ia.</u>	<u>Nishnabotna R. nr. Hamburg, Ia.</u>
January	2.3	2.1	3.3
February	6.8	8.2	8.2
March	16.5	16.4	18.6
April	8.1	9.6	7.9
May	14.0	13.2	9.7
June	17.0	15.4	16.6
July	10.9	10.9	10.7
August	7.8	7.2	8.6
September	6.5	6.8	6.1
October	4.1	3.7	3.7
November	3.4	4.0	3.7
December	2.6	2.6	2.9

*Percentage distribution of annual flows based on monthly median flows for the period of record.

Ground Water

The ground water supplies in the basin are plentiful and used by all municipalities for their water supply. The three main sources of supply for ground water are shallow unconsolidated deposits, deep unconsolidated

deposits, and consolidated rocks, however, exploration for the latter two sources is usually difficult and expensive. In the larger alluvial areas along the lower lying streams and rivers, ground water is normally available so approximately 97 percent of the developments in the basin have been made in the shallow aquifers adjacent to the streams. These are tapped by gravel-packed wells, well points, and similar devices. The installations are relatively cheap, but pumping costs are appreciable since many of the well fields are at lower elevations than the cities or industries which they serve and are often removed by considerable distances. The quantity of water in million gallons per day (mgd) taken by municipalities from each of the three horizons and from surface sources, and the percentage of the total from each source is shown in Table V-2.

Table V-2

Sources of Water for Municipal Supply
Nishnabotna River Basin

<u>Source</u>	<u>Quantity (mgd)</u>	<u>Percentage of Total</u>
Shallow unconsolidated deposits	3.811	97.3
Deep unconsolidated deposits	0.072	1.8
Consolidated rocks	0.035	0.9
Surface sources	None	0

VI. THE ECONOMY

Economic and demographic data presented herein, will serve as a base from which future municipal, industrial, and quality control water use and anticipated waste discharge can be projected.

The study area, for statistical interpretation, is defined as the following counties of Iowa: Audubon, Cass, Fremont, Mill's, Montgomery, Page, Pottawattawie, and Shelby. The Council Bluffs Standard Metropolitan Statistical Area (SMSA), located in Pottawattawie County, is included in this section of the report, although it lies well outside the Nishnabotna River Basin.

The historic economic data contained in this report were obtained primarily from published information by Federal, State, and local agencies. All population data and projections appearing in this report were furnished by the Omaha District Corps of Engineers.

Past and Present

Population data for 1910 show a total basin population of 176,000, with rural residents totaling 120,000 and an urban population of 56,000. By 1960, total area population had increased to 186,000. While rural population had diminished to 88,000, the urban segment increased to 98,000.

While total basin population seems to have remained almost static, considerable movement within the basin from rural to urban areas is noted.

Agriculture is the overriding and dominant economic parameter of the study area. In 1960, 23 percent of the total labor force, approximately 16,000 persons, were employed in agriculture. Eleven percent of the labor force, 8,000, were employed in manufacturing, while 63 percent, 45,000, occupied positions in the service category. Less than 1 percent were employed in mining with the remaining 3 percent unemployed.

Agricultural employment decreased by approximately 26 percent from 22,000 in 1950 to 16,000 in 1960. During the period from 1954 to 1964, there was a decrease in the total number of farms from 15,000 to 12,000. Accompanying this was a reduction in the cropland harvested from approximately 1,856,000 acres to 1,514,000 acres in 1954 and 1964, respectively. During this same period, the total value of all farm products sold increased from \$168 million to \$226 million adjusted to the 1964 dollar value. Much of this increase was due to increased productivity, consolidation of farms, and improved agricultural technology.

Manufacturing in the study area is predominantly agriculture oriented. Processing of food and farm products and manufacturing and fabrication of farm machinery are the two largest industries in the basin.

Future

While economic growth is projected to continue within the study area, no major influence is seen that would markedly affect the present rate of economic development.

Projections furnished by the Omaha District Corps of Engineers show a population increase from 186,000 in 1960 to 204,000 in 1980, 260,000 in 2020, and 390,000 in 2070. Further breakdown by county can be obtained from Table VI-1.

As the basin economy changes from a producer of agricultural commodities to an exporter of processed farm products, farm machinery, and related goods and services, the pattern of employment will change. However, no heavy water-using or waste contributing industries are projected to locate in the area.

Industrial water demands and waste loads are expected to increase at the same rate as the population through 2070. These demands and waste loads will be satisfied and treated along with the requirements of the population.

Table VI-1

Population Data
Nishnabotna River Basin
1940-2070

<u>Counties</u>	<u>1940</u>	<u>1950</u>	<u>1960</u>	<u>1980</u>	<u>2000</u>	<u>2020</u>	<u>2070</u>
Audubon	11,790	11,579	10,919	9,400	9,100	9,400	13,000
Cass	18,647	18,532	17,919	18,600	21,600	23,400	30,000
Fremont	14,645	12,323	10,282	6,200	5,000	4,100	6,000
Mills	15,064	14,064	13,050	12,900	13,300	13,800	17,000
Montgomery	15,697	15,685	14,467	14,900	15,900	17,300	22,000
Page	24,887	23,921	21,023	21,500	24,200	26,700	40,000
Pottawattamie	66,736	69,682	83,102	105,300	125,700	147,400	234,000
Shelby	16,720	15,942	15,825	15,100	16,200	18,200	28,000
TOTALS	184,206	181,728	186,587	203,900	231,000	260,390	390,000

Table VI-2

Employment Data
Wishnobotna River Basin

	1950		1960	
	<u>No.</u>	<u>Percent</u>	<u>No.</u>	<u>Percent</u>
Agriculture	22,123	32	16,388	23
Mining	113	-	72	-
Manufacturing	4,798	7	7,966	11
TOTAL BASIN	27,034	39	24,426	34
TOTAL SERVICE	40,686	59	44,575	63
UNEMPLOYMENT	<u>1,233</u>	<u>2</u>	<u>2,125</u>	<u>3</u>
TOTAL LABOR FORCE	68,953	100	71,126	100

Table VI-3

Agricultural Data
Wishnobotna River Basin

	<u>1954</u>	<u>1959</u>	<u>1964</u>
No. of Farms	14,704	13,075	11,531
Land in Farms (1,000 acres)	2,730	2,736	2,738
Cropland Harvested (1,000 acres)	1,856	1,812	1,514
Value of farm products sold (millions \$) (adjusted to 1964 \$ value)	168	207	226

VII. WATER QUALITY CONTROL

Municipal, Industrial and Agricultural Pollution

Five municipalities over 2,500 population and many smaller communities are located in the Wisconsin River Basin. Figure 2 is a schematic drawing of the basin with the municipalities shown in their respective locations. The majority of the small communities do not have sewage treatment but all of the larger ones have secondary treatment. Exhibit 1 of the Appendix lists the principal municipalities with their population, water supply and waste treatment.

Industries in the basin which contribute significant amounts of wastes are limited to a scattering of dairies and creameries with a rendering plant and packing house at Harlan. Exhibit 2 of the Appendix lists these industries.

Sufficient data are not available to quantify agricultural pollution in the form of runoff from fields and feedlots and pollution by pesticides.

Water Quality Objectives

Water quality control needs are governed by the uses for which a stream is intended. Contaminated water can endanger the health of persons living near or coming in contact with the streams and unattractive water can reduce the esthetic enjoyment of living in the vicinity of streams, rivers and lakes. Failure to provide water of an acceptable quality can prevent the best use of a stream.

Available data indicate that the chemical quality of the surface waters in the basin are within the range of the recommended U. S. Public Health Service 1962 Drinking Water Standards. It is expected that there will be no mineral pollution from irrigation return flow or industrial water, so quality control

needs are based on the effect of organic material on the stream. The effect of organic waste discharge and the hydraulic characteristics of individual streams are reflected in the dissolved oxygen level. Some dissolved oxygen is necessary to prevent nuisance conditions and concentrations of at least 3-5 mg/l are necessary to maintain fish and other aquatic life associated with desirable recreational use of a stream.

Flow Regulation

The Federal Water Pollution Control Act, as amended (33 U.S.C. 466 35 et seq.) provides that consideration must be given in the planning of a reservoir by a Federal Agency to the inclusion of storage for regulation of stream flow for the purpose of controlling water quality. The law also states that such storage and water releases shall not be provided as a substitute for adequate treatment or other methods of controlling waste at the source. For domestic wastes, it is considered possible to obtain 85 to 90 percent removal of BOD with well operated secondary waste treatment plants.

Biological oxygen demand (BOD) removal of 90 percent in 20/0 was considered reasonable for this project. Municipal and industrial water demands were considered to be 125 percent of the average annual water demand and the return water was considered to be 70 percent of the water used during the summer months.

Similarly, 100 percent demand and 78 percent return were used in the spring and fall, and 75 percent demand and 88 percent return in the winter months. An ultimate first stage BOD of 0.25 pounds per population equivalent was used in the estimation of dilution requirements.

Discharge of wastes, even where treated to the maximum extent technically and economically feasible, will cause an unsatisfactory condition in water in which the waste assimilation capacity is exceeded.

Streamflows necessary to assimilate the anticipated municipal waste treatment plant effluents have been estimated on a seasonal basis for the waste loads anticipated in 1970, 2020, and 2070. In these estimates the water temperature for summer (June, July, August and September) averaged 24°C, spring and fall (April, May, October and November) 12°C, and winter (December, January, February, and March) 1°C.

The available streamflow is considered adequate to assimilate wastes in 2070 at all communities in the basin except Audubon on Blue Grass Creek and Harlan on the West Nishnabotna River. The minimum streamflow anticipated for quality control at the two locations is shown in Table VII-1.

Provisions for storage to assure that flows are met 90 percent of the years is considered desirable. Actual releases should be based on observation of water quantity and quality; taking into account temperature, wastes actually reaching the stream, the quantity of water available in storage at the time, and anticipated rainfall.

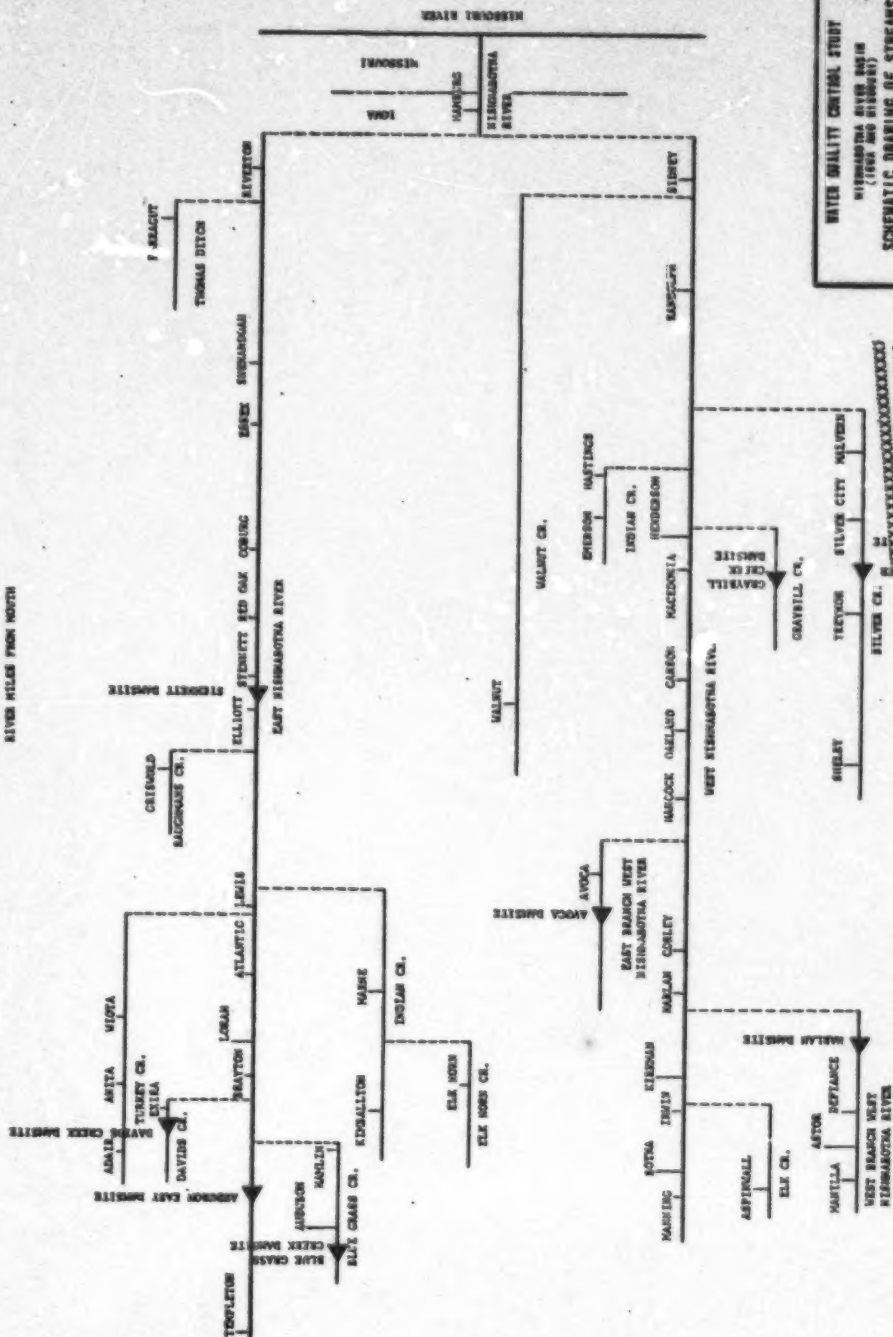
Table VII-1

Minimum Streamflow Required
for Quality Control

<u>Location</u>	<u>Year</u>	<u>Minimum Streamflow Requirement (million gallons per day)</u>		
		<u>Spring & Fall</u>	<u>Summer</u>	<u>Winter</u>
Audubon (Blue Grass Creek)	1970	0.5	1.5	0.3
	2070	1.7	4.4	0.9
Harlan (West Nishnabotna River)	1970	4.1	13.6	2.9
	2070	10.6	28.6	5.0

150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0

RIVER MILES FROM MOUTH



WATER QUALITY CONTROL STUDY
WEST BRANCH OF THE MISSOURI RIVER
(FROM THE MOUTH)
SCHEMATIC DRAWING OF STREAMS,
RESERVOIRS AND MUNICIPALITIES
P. H. GORDON, JR., OF THE UNIVERSITY
OF MISSOURI, WATER POLLUTION CONTROL ADMINISTRATION
ST. LOUIS, MISSOURI

See the following pages
for greater detail.

VIII. BENEFITS

Water Quality Control

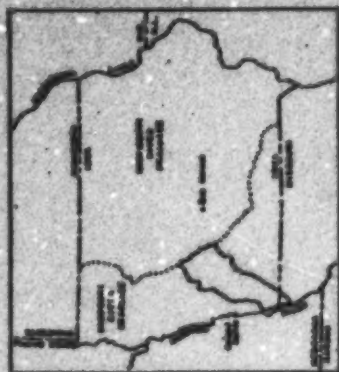
Benefits attributable to storage for streamflow regulation for water quality control may or may not have a measurable dollar value. Benefits can be provided from the recreational use and improved esthetics of the stream stemming from clean surface waters.

Water quality control management by the proposed reservoirs in the Nishnabotna River Basin will provide benefits from recreational use of approximately 280 river miles of the streams from the damsites to the mouth. Assured water quality will provide more favorable conditions for recreation such as swimming and fishing with a safe public health environment and the absence of noxious odors, floating solids and excessive turbidity. The total population of the study area is estimated to be 390,000 by 2070. It is reasonable to anticipate that a large portion of the total population in the study area, including Council Bluffs SMSA, will be able to enjoy the recreational opportunities offered.

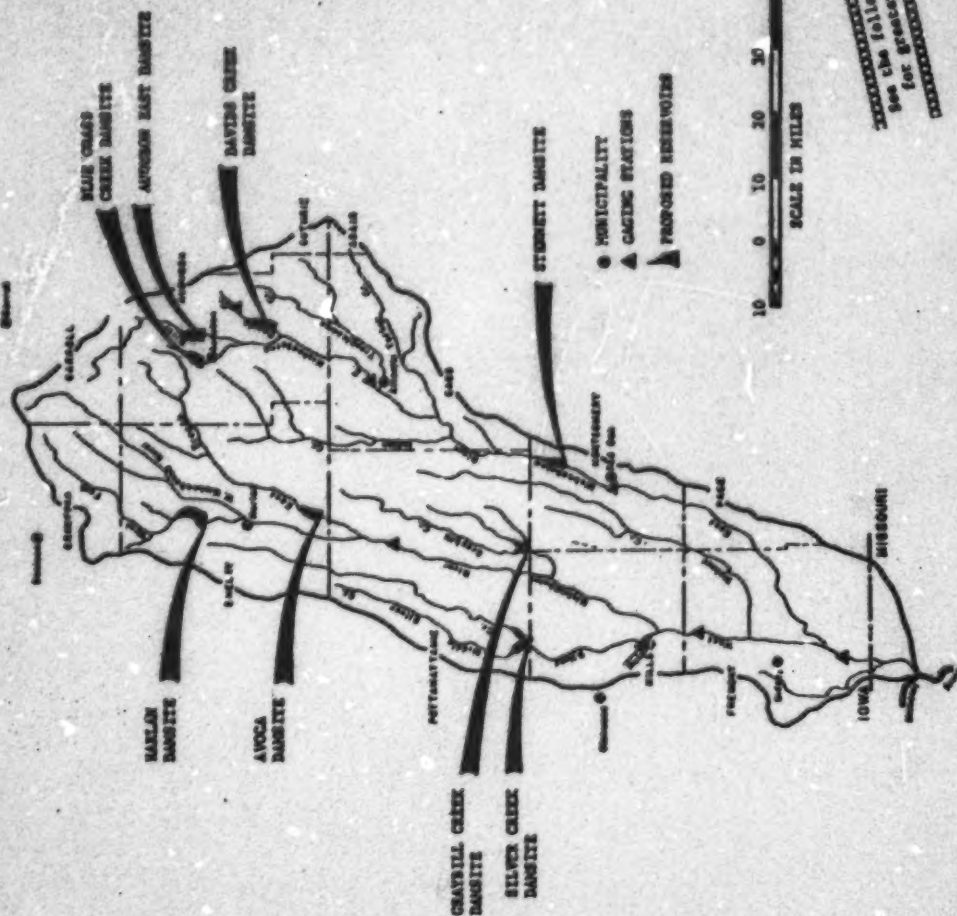
At Audubon, on Blue Grass Creek, the amount of water needed to assimilate the 1965 waste loading on a 1 in 10 year low flow was barely adequate in August and September. In 2070 the 1 in 10 year flow will be inadequate from April through January. In the absence of adequate means of evaluating directly the economic effects of water quality control, the cost of achieving the same results by the most likely least cost alternative has been used to approximate the value of benefits anticipated. After considering various methods of providing the required water quality

control, it is concluded that an 18 inch pipeline from Audubon to the East Nishnabotna River, a distance of approximately five miles, is the most acceptable alternative. The East Nishnabotna River has adequate flows to completely assimilate Audubon's wastes 9 out of 10 years. The value of the alternative is \$11,400 per year including operation and maintenance. This is based on a capital cost of \$316,800 amortized at a rate of 3 1/8 percent for 100 years, and includes \$1,000 per year for operation and maintenance.

At Harlan, on the West Nishnabotna River, the 1 in 10 year low flow is considered adequate to assimilate the waste loadings with 85 percent treatment until about 1980. By 2070 the flows will be deficient in August and September by about 1,450 acre-feet. It is considered that a 16 acre, 10 feet deep holding pond is the most acceptable alternative. The holding pond would be filled with excess effluent during the months of August and September and then emptied during the winter and spring seasons when flows are sufficient to assimilate the loadings from the pond. The value of the alternative is \$7,530 per year including an operation and maintenance cost of \$5,000 per year. This is based on a capital cost of \$160,800 amortized at a rate of 3 1/8 percent for 100 years. This value was discounted to 1970, from the year of first need (1980).



Location Map



WATER QUALITY IMPROVEMENT STUDY
 MISSOURI RIVER BASIN
 (1960 AND 1961)
 LOCATION MAP
 23
 U.S. DEPARTMENT OF THE INTERIOR
 BUREAU OF RECLAMATION
 FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
 1400 GARDEN AVENUE, COLUMBIA, MISSOURI 65201

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X. APPENDIX

Exhibit No. 1

Mississippi River Basin
Municipal Water Supply and Waste Disposal

Town	Popula- tion 1960 Census	<u>Water Supply</u>		<u>Waste Treatment</u>	
		Water Use Average (mgd)	Source of Water	Type of Treatment	Population Equivalent (Effluent)
Adair	742	0.040	Wells	No sewage system	-----
Anita	1,233	0.095	Wells	Secondary	80
Aspinwall	95	0.015	Wells	No sewage system	-----
Atlantic	6,890	0.600	Wells	Secondary	1,200
Audubon	2,928	0.225	Wells	Secondary	200
Avoca	1,540	0.270	Wells	No treatment	3,360
Brayton	225	---	---	No sewage system	-----
Carson	583	0.045	Wells	No treatment	400
Coburg	54	---	---	No sewage system	-----
Defiance	386	0.006	Wells	No sewage system	-----
Elk Horn	679	0.050	Wells	No sewage system	-----
Elliot	459	0.062	Wells	Secondary	70
Emerson	521	0.025	Wells	No treatment	450
Exira	1,111	0.095	Wells	Secondary	100
Essex	767	0.090	Wells	Secondary	135
Farragut	495	0.050	Wells	Secondary	265
Gray	152	0.001	Wells	Secondary	35
Griswold	1,207	0.160	Wells	No sewage system	-----
Hamburg	1,647	0.090	Wells	Secondary	113
Hancock	252	0.012	Wells	No treatment	1,000
Harlan	4,350	0.500	Wells	No treatment	220
Hastings	260	0.004	Wells	Secondary	6,400
Henderson	191	0.004	Wells	No sewage system	-----
Imogene	264	---	---	No sewage system	-----

Municipal Water Supply and Waste Disposal (Cont'd)

<u>Town</u>	<u>Popula- tion 1960</u>	<u>Water Use Average (mgd)</u>	<u>Source of Water</u>	<u>Type of Treatment</u>	<u>Population Equivalent (Effluent)</u>
Irvin	425	0.030	Wells	Secondary	40
Kimballton	380	0.020	Wells	No treatment	780
Kirkman	92	0.004	Wells	No sewage system	---
Lewis	501	0.052	Wells	No sewage system	---
Macedonia	290	0.024	Wells	Secondary	30
Malvern	1,193	0.090	Wells	No treatment	2,000
Manilla	939	0.066	Wells	Primary	500
Manning	1,676	0.160	Wells	Secondary	350
Marne	205	0.003	Wells	No sewage system	---
Oakland	1,340	0.125	Wells	No treatment	1,500
Randolph	257	0.030	Wells	No sewage system	---
Red Oak	6,421	0.750	Wells	Secondary	660
Riverton	399	---	Wells	No sewage system	---
Shelby	553	0.028	Wells	Secondary	50
Shenandoah	6,567	0.700	Wells	Secondary	700
Sidney	1,057	0.100	Wells	Secondary	300
Silver City	281	0.200	Wells	No sewage system	---
Templeton	354	0.025	Wells	No sewage system	---
Treynor	368	0.028	Wells	Secondary	25
Walnut	777	0.070	Wells	Secondary	60
Wiota	195	0.010	Wells	No sewage system	---

Exhibit No. 2

Nishabotna River Basin
Industrial Waste Sources

<u>Community</u>	<u>Industry</u>	<u>Average Output (mgd)</u>	<u>Maximum Output (mgd)</u>	<u>Source of Water Supply</u>	<u>Method of Waste Disposal</u>
Avoca	Farmers Coop. Creamery	.025		Municipal	Untreated
Essex	Saunders Dairy			Well	Municipal System
Griswold	Baldwin Dairy			Well	Municipal System
Harlan	Harlan Auction				Municipal System
	National By-Products	0.192	0.240	Well	Hot Well
	Western Iowa-Pork, Inc.	0.240	0.384	Well	Lagoon
Kimballton	Crystal Springs Creamery			Spring & Well	Septic Tank for Toilets
Malvern	Henningson's Food			Municipal	Untreated
Manning	Manning Creamery			Municipal	Municipal System
Red Oak	All Star Dairies	0.020		Municipal	Municipal System